Comparison of cardiac structural, functional indices of male elite swimmers and triathletes with non- athletes

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Abstract: The purpose of this study was to investigate structural and functional cardiac indices in elite male swimmers and traithletes versus non-athletes. 20 elite male athletes (10 swimmers and 10 traithletes) and 10 healthy non-athletes volunteers participated in this study. Structural and functional cardiac indices measured by two dimensional, M mode and Doppler echocardiography. Data were analyzed by ANOVA, post-hoc Tukey and Pearson´ correlation coefficient at significance level 0.05. M-mode and two-dimensional measurements of the right and left ventricular cavity and wall were obtained in elite orienteers and sedentary males. For the right ventricle and wall, multiple cross-sections were used and measurements were obtained from the right ventricular inflow and outflow tract. The results indicated that LVDd was significantly greater in the thriathletes compared with the non-athletes (P<0.05). In addition, PW was significantly greater in thriathletes compared with the non-athletes (P<0.05). Moreover, LVM was significantly greater in all athletes compared with non-athletes, but athletes have less HR and RPP (P<0.05). However, there weren't significant differences between groups for Q, EF% and FS% (P>0.05). In the end, the results indicated a close linear correlation between LVM with LVD and PW.

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1. Introduction

Exercise and physical activity form the part of everyday life for most people. Medical research now suggests that sporting activities in addition to recreational aspects have essential for health and mental relaxation (9). In addition, the study of persistent and hard-working athletes, young athletes compared with elderly one, active patients versus inactive patients can be interesting source of useful and harmful data in the field of sport activates and cardiovascular disorders'. In the case, the heart key role can be inevitable in providing the required needs of body especially physical activities (9). Heart with regular exercise and long- term changes is being distinct from non-athlete heart because of these different changes. The changes and structural adaptations and the performance of the heart in response to the regular exercise is considered as a physiological phenomenon opposed to pathological conditions (1). These changes are mainly happening as an increase of the size, dimensions, the thickness of ventricular wall, diastolic end volume, ejection fraction, stroke volume and decrease of beat and multiplying beat – pressure (RPP) at the rest time. However, the effects of different sport activities depend on the race, heredity, gender, physical fitness, type, severity and duration of the activity (3). Aerobic and endurance activities follow the extrovert hypertrophy patterns through putting overloaded volume in the heart muscle (cardiac muscle). Athletes participating in this type of end diastolic Volume, have stronger left ventricular mass, larger ventricular capacity and most powerful myocardial contraction (3); While the pattern of changes in the strength or power athletes due to the pressure is as introvert hypertrophic and it is associated with increased ventricular wall thickness that the ventricular cavities and stroke volume never increases (1). However athletes in many sports are usually forced to use a combination of exercises due to the continuum between endurance and strength; triple exercise is as exercises that an athlete regularly and frequently participates in swimming, cyclying and running ; according to the results of some studies, the triple exercise with both pressure and volume characteristics may be a combination of hypertrophy pattern (introvert extroverts) (4). However, research results related to the combined effects of exercise on indices of myocardial structure and function, is somewhat contradictory. King et al. (2008) also studied the cardiac changes among elite sailings and found that there is a significant difference between the left ventricular wall thickness, size and end diastolic and systolic volume of the left ventricular cavities in boat- riders and non- athletes (5).

The exercise tests, echo and electrocardiography have used vastly for showing the accurate effects of aerobic and non- aerobic exercises on the athlete's heart. The information obtained in this manner helps coaches to train athletes who are able to withstand any pressures. Echocardiography is as a non- invasive and safe diagnostic tool for determining the changes and adaptations resulting from exercise in athletes; ; However, few studies have been carried out in this field especially in the new sport fields especially in the new sport fields such as triple sports; therefore, due to the new format of triple sports in Iran, the internal and external contradictory findings and involving different parts of the body in terms of swimming, cycling and running have been found and the present study has been fulfilled as semi0experimental along with structural and functional indices of elite swimmer's heart, swimmers, traithletes and non- athletes.

2. Methods

Among the community of East – Azerbaijan athletes, 20 male elite swimmer and traithletes were volunteerly selected as an available sample; while in control group, 10 healthy non- athletes (with on history of heart problems, cardiovascular or taking regular doses of certain drugs) were chosen. Moreover, none of the subjects of control group had any regular history of exercises or any activity in a certain sport field. (Table 1).

Table 1. personal characteristics of subjects

Measured indices	Swimmers	Traithletes	Control
Age	17.1±0.99	18.7±1.49	19.5±1.08
Height	174.9±5.25	175.7±4.87	172.8±5.05
Weight	64.8±10.03	65.2±4.15	65.5±4.27
Body mass index (BMI)	21.07±3.15	21.11±0.94	22±2.14
Percentage of fat	11.79±1.66	9.91±1.67	19.08±1.96
Surface of body surface (m^2)	1.78±0.16	1.79±0.07	1.77±0.05
Maximal oxygen uptake	50.9±3.25	58.14±4.8	22.95±1.84

2.1. Methods of variables measurement:

The weight and height of the subjects were measured, respectively, by the use of analog scale (with accuracy of 0.1 Kg) and the Japanese standard height gauge (with accuracy of 0.1 mm); then, the body mass index (BMI) using weight (kg) to squared height (meters squared) was calculated. The surface of body surface also using a chart to estimate the total body surface (the diagram of height- weight) was determined per square meter (12). The systolic and diastolic blood pressure of the subjects was measured by the use of measuring and edictal devices, Auscultatory method, 10 to 15 minutes rest time sitting on a chair; To estimate the Maximum oxygen consumption (Voz_{max}) of the subjects, Queen step test was performed after 5minute warming up and stretching the involved muscles (Hamstring, four-headed, twins, Achilles tendon) with metronomy to 96 hit songs (24 steps per minute) on a step height of 41.3 cm. the heart periodical recovery beat of the subjects was recorded five seconds after an aerobic power test as standing mood using a polar heart- rate meter for 15 seconds and multiplied in 4 (heartbeats per minute). Their maximum oxygen consumption also was estimated by the following formula per (ml/ kg/ min): (6)

Maximal oxygen= 111.23-(0.42)× (recovery of heart rate per number of beats in minute)

The percentage of body fat was anticipated by using skin thickness (caliper) and a three- point formula (book of upper arm, abdomen and right perivs) (7).

Percentage of = (0.39287) × (total of three – points) - 0.00105× (total of three points)^2+ [0.15722× (age)] - 5.188

The structural indices of End- diastolic posterior wall thickness (PWD), End- systolic posterior wall thickness (PWs), left ventricular systolic dimensions (LUD_d) and left ventricular systolic dimensions (LVD_s), left ventricular mass (LV_m) along with other functional indices and indicators of Ejection fraction (%EF) and fractional shortening percent (%FS) in left ventricle were measured by the use of two- dimensional echocardiography and Doppler with echocardiograph MEGA, Model 2005 made in Italy; then, by the use of following formula, stroke volume (SV), Cardiac output (q), RPP, LVVd and LVVs were estimated.

The research hypotheses using inferential methods were studied in the significance level (> 0.05) which at this stage, the one- way variance analysis test was applied to compare the groups and their differences; In this regard, the post hoc Turkey test was used to find any differences among the groups. Finally, the relationships of some variables using Pearson correlation coefficient and multiple regression were examined.

3. Results

Based on the obtained results, in LVD_d index only significant difference was observed between control group with triple groups and runner, but there is no any significant difference between groups in relation to LVD_s.

In indices of PWd and PWs also observed significant difference between control groups with triple, runner and cyclists groups. Also, in the stroke volume, the only significant difference between groups in relation to LVD_s.

In indices of PWd and PWs also observed significant difference between control groups with triple, runner and cyclists groups. Also, in the stroke volume, the only significant difference was observed between control group with triple and runner groups. In indices of LVm, HR, RPP, there were significant difference between control group and there rest of the groups; but, in cardiac output (Q), there were not observed any significant difference between% EF and % FS. In sport groups, there is only a significant difference in PWD between swimming groups with triple groups and cycling; finally, according to the results of Pearson correlation coefficient that there is a negative significant relationship between the heartbeat with left ventricular dimensions in the end-Diastolic, the thickness of posterior wall in the end-Diastolic, left ventricular mass and stroke volume. These results were reverse in the stroke column size. The following table summarizes the findings of the study as follows:

Table 2. Result of the study

Structural and functional indices of the heart	Fields		
	Swimmers	Triathletes	Non-athletes
(LVDd) (cm^3)	5.11± 0.5	5.34±0.35	4.82±0.4
(LVDs) (cm^3)	3.25 ± 0.45	3.54±0.48	3.17±0.21
(PW_d) (cm)	0.94 ± 0.12	1.08±0.1	0.83±0.04
(PW_s) (cm)	1.46 ± 0.28	1.53±0.16	1.09±0.03
(LVM) (gr)	222.9 ± 18.19	266.87±20.75	155.8±21.43
HR	68.4 ± 8.55	66.6±4.37	82.5±4.99
RPP ($mmhg*min/b^p$)	8310.8 ± 941.2	8033.2±617.5	10148±838.5
SV (ml)	82.2 ± 6.6	86.1±5.8	65.8±5.8
Q (L/min)	5.6 ± 0.5	5.6±0.3	5.4±0.5
EF (%)	65.4 ± 8.1	62±5.5	60.4±6.7
FS (%)	36.5 ± 6.3	34.1±8.4	33.9±4.9

Based on the results, there is a positive significant relationship between the left ventricular mass with the dimensions of the left end- diastolic and systolic ventricle, and the thickness of posterior wall in the end diastolic and systolic; furthermore, according to the results of the pearson test and multiple regression, the percentage of fat, maximal oxygen consumption and structural variables such as the dimension and left ventricle mass can be measured.

4. Discussion and Conclusion

Based on the results of the present study, the left ventricular end diastolic dimension (LVD_d) was significantly larger in traithletes and runners in the control group (P<0.05). Although cyclists and swimmers also had larger LVDd than controls but there was no significant difference between them; Also, between the different sport fields no any significant difference found. Due to the distribution of the groups and athletes of four sport fields who participated in the present study, the findings cannot be blamed entirely for or against previous researches'. However, most previous research also pointed to the significance difference of LVD_d among endurance athletes and non- athletes. It can be stated that, although taller and muscular athletes are stronger than nonathletic individuals, but the size of their end diastolic is also larger than usual people; achieving frequent activities cause to an increased diameter and volume of ventricle muscles (2); of course, and increase of the size and left ventricular dimensions has been reported after one week endurance exercise while the cardiac muscle mass indicates while the cardiac muscle mass indicates slower reaction in this regard. The rapid increase if the cardiac sizes is firstly due to the rapid increase of blood and plasma (4). Dynamic movements and isotonic exercises with long- term increase due to the overloaded volume from the volume of high output and left ventricular cavity size (8). The hemodynamic changes and loads imposed on the ventricle and ventricular hypertrophy. These training stimulus cause to a significant increase in end- diastolic volume which in effect also greatly increases stroke volume (4). In the field of running with severe and high- potential exercises, this increases the dimensions and ventricular volume; in the triple field, the cardiac system to lerate overloaded pattern resulting in the elements of exercise intensity and duration. (1, 9); however, the findings of the present study are not matched with the results of Tosk et al (2009) and persinjin et al (2007) (10, 11); In this regard, the results of the left ventricular end- Diastolic dimensions indicating the lack of significant difference between the related groups. In the thickness of posterior wall in end-diastolic and systolic between control groups with triplets, runners and cyclists, runners and cyclists there were significant differences in which they were larger than control group (P<0.01). The thickness of posterior wall of end- diastolic in swimmers was smaller than traithletes (P<0.05), which it was due to the low age of swimmers. Although swimmers begin their activities earlier than other athletes, the age of selected swimmers was lower than other athletes, too. Of the left ventricular mass that was significantly lower than athletes, there was no found any significant difference between sport groups. In relation to the performance indicators, the amount of heartbeat and double multiple in sport groups was significantly lower than control group; but in the stroke volume index the only significant difference was observed between the control group and traithletes; but in the cardiac output index, ejection fraction and shortening time between the control group and the athletes no found any significant differences. Long- term exercises increase parasympathetic activity and may decrease the sympathetic activity and also reduces the irritation of the sinus- atrial node that these adaptations are due to the low heart- rate of endurance athletes. (9); this reduction leads to the decrease double multiple imposed pressure into the heart at relaxation time. As the results of the present study showed, the reduction of the cardiac rate is compensated due to the increased stroke volume in which this is very obvious in the fields of running and triple sports. Therefore, it is not unexpected that there is no observed any significant difference in the cardiac output, ejection fraction and shortening time among athletes and non-athletes at relaxation period.

According to the results of the present study and previous researches, it can be stated that the long-term exercises make a tangible changes in the structure of the heart (cardiac tissue) increasing the left ventricular mass of the athletes. It seems that triathletes have both features of cardiac power and endurance. However, researches related to these kinds of sport field are at the beginning and any definite statements about cardiovascular adaptations depend on many researches.

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